

Minnesota Space Grant Consortium
Lead Institution: University of Minnesota
Director: William L. Garrard
Telephone Numbers: 612-626-9295 or 612-625-9002
URL: <http://www.aem.umn.edu/mnsgc/>
Grant Number: NNX10AL98H

PROGRAM DESCRIPTION

The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowships and scholarships programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA's interest as implemented by alignment with the Mission Directorates and the state's interests. Although it is primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The Minnesota Space Grant Consortium is a Designated Consortium funded at a level of \$845,000 for fiscal year 2010.

PROGRAM GOALS

Outcome 1 – Higher Education: *Contribute to the development of the STEM workforce in disciplines needed to achieve NASA's strategic goals.*

Goal 1.1: Enhance diversity in the STEM workforce by providing research and higher education opportunities to women students and students from underrepresented groups.

Goal 1.2: Contribute to the STEM workforce by providing research and higher education opportunities to high-performing undergraduate and graduate students attending MnSGC institutions.

Goal 1.3: Enhance diversity in the STEM workforce by providing scholarship and fellowship support to women students and students from underrepresented groups.

Goal 1.4: Contribute to the STEM workforce by providing scholarship and fellowship support to high-performing undergraduate and graduate students attending MnSGC institutions, including support for students to participate in NASA Center internships.

Goal 1.5: Contribute to the STEM workforce by enhancing higher education opportunities for high-performing undergraduate and graduate students attending MnSGC institutions through aerospace design projects and student satellite projects.

Goal 1.6: Contribute to the STEM workforce by promoting higher education course development in areas of interest to NASA at MnSGC institutions.

Goal 1.7: Enhance diversity in the STEM workforce by promoting research and/or higher education programming at tribal college affiliates of the MnSGC.

Outcome 2 – Elementary and Secondary Education: *Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty.*

Goal 2.1: Enhance the teaching of STEM topics, especially in schools with high underrepresented populations, by supporting precollege teachers through a variety of aerospace-related professional-development opportunities.

Outcome 3 – Informal Education: *Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA’s mission.*

Goal 3.1: Promote familiarity with, and interest in, aerospace and space-related STEM fields and career opportunities by offering a variety of informal education activities around the state.

PROGRAM/PROJECT BENEFIT TO OUTCOME (1, 2, OR 3)

Outcome 1:

- High-altitude ballooning activities on-going at 5 institutions in the MnSGC, plus one ballooning program inspired at a non-member institution
- Flew last year’s suborbital payload from NASA Wallops Flight Facility and supported student teams building 2 additional payloads this year, involving cooperation between 2 MnSGC institutions
- New high-powered rocketry programs initiated at one community college and at the lead institution – ongoing programs at 2 colleges with tribal connections
- Aerospace engineering, physics/astronomy, and geology research conducted at the lead institution and at multiple affiliates
- Funded 12 student interns at NASA Centers
- Freshman seminars on both high-altitude ballooning and RC aircraft now being offered at the lead institution
- Supported course revision/development in experimental physics, including applications of high-altitude ballooning, electronics, and optics, as well as astronomy, including Native American astronomy and astronomy for pre-service teachers
- Hosted the Fall 2010 Space Grant Great Midwest Regional Meeting including a student poster competition with more than 50 entries

Outcome 2:

- Summer aerospace workshop for teachers conducted by MnDOT, our one state government affiliate
- Held two aerospace curriculum sessions at the “E4” (Excellence in Elementary Engineering Education) teacher conference
- Engaged Native American middle school students on a rural reservation in high-altitude ballooning and also conducting on-going balloon payload-building activities with teachers and students at 12 additional middle schools in the Twin Cities metro area
- Involved teachers and students at 2 Twin Cities high schools in suborbital rocketry payload-building

Outcome 3:

- Planetary geology exhibit under development at a Science Center in Bemidji

- Day-long exhibit at the MN State Fair, staffed mostly by college students, including live tracking of a high-altitude balloon mission
- Continuing Education class entitled “Space Camp – Minnesota Style” offered at the lead institution
- Regular astronomy/telescope evening events for school children and the general public held at 2 affiliates

PROGRAM ACCOMPLISHMENTS

Outcome 1: *Contribute to the development of the STEM workforce in disciplines needed to achieve NASA’s strategic goals: (Employ and Educate)*

Goal 1.1: Enhance diversity in the STEM workforce by providing research and higher education opportunities to women students and students from underrepresented groups.

Objective 1.1.A: Involve underrepresented groups in out-of-class higher education programs to at least a minimum percentage equal to Minnesota demographics for enrollment in higher education (Native American 1.3%, African American 8.9%, and Hispanic 2.3%, for a total of 12.5%) and 50% for women students in 2010-2011.

Results: Partially achieved. Of 45 total out-of-class higher education participants, 16 were women (36%) and 18 were from underrepresented groups (40%). This indicates that we need to put renewed emphasis on recruiting and engaging women students in these out-of-class opportunities.

Objective 1.1.B: Involve underrepresented groups in research programs to at least a minimum percentage equal to Minnesota demographics for enrollment in higher education (12.5% – see Objective 1.1.A above) and award 50% of the research stipends to women. This year we plan to fund a minimum of 4 students from underrepresented groups and 15 women students to participate in research in 2010-2011.

Results: Partially achieved. Of 38 total research stipends awarded, 10 were given to women (26%) and 4 were given to students from underrepresented groups (11%). We traditionally fund most of our undergraduate research at affiliates. This year several affiliates who historically have had a large number of women participate in these programs had very few. We need to work harder to recruit both women and minorities to our undergraduate research activities.

Goal 1.2: Contribute to the STEM workforce by providing research and higher education opportunities to high-performing undergraduate and graduate students attending MnSGC institutions.

Objective 1.2.A: Offer high-quality research experiences for at least 38 undergraduate students across the MnSGC in 2010-2011 that motivate students to work in areas of direct interest to NASA and NASA contractors or to pursue graduate studies in aerospace science and engineering.

Results: Achieved. In all 38 students received research stipends in 2010-2011. An additional 9 students did research at the lead institution but were funded through fellowship/scholarship awards instead of with programmatic research stipends.

Objective 1.2.B: Fund graduate-level research in aeronautics and space physics in areas in which the Principal Investigators have strong, formal relationships with

NASA Centers by funding at least 2 Ph.D. students, 1 in Aerospace Engineering and 1 in Space Physics in 2010-2011, as well as at least 4 additional graduate students in aerospace science, engineering, and/or related fields through the fellowship budget or directly.

Results: Achieved. Five Ph.D. students from the School of Physics and Astronomy, one Ph.D. student in Aerospace Engineering, and two Masters students in Aerospace Engineering were partially supported with fellowships to do research. All students worked on research under advisers with strong formal relations with NASA Centers.

Objective 1.2.C: Provide seed funding to assist investigators with little or no previous contact with NASA develop collaborative programs with Centers and Directorates. Expect at least 1 young investigator will be partially funded to seek collaborative contacts with appropriate NASA Centers.

Results: In progress. The research programs of several young investigators within MnSGC have been partially funded, enabling them to accomplish more research and establish collaborations with more-senior faculty within the state that have NASA connections. We anticipate 1 or more of these young faculty will establish direct NASA Center connections for their own research in the near future.

Goal 1.3: Enhance diversity in the STEM workforce by providing scholarship and fellowship support to women students and students from underrepresented groups.

Objective 1.3.A: Provide scholarships (and fellowships) for underrepresented students to at least a minimum percentage equal to the most recent Minnesota demographics for enrollment in higher education (12.5% – see Objective 1.1.A above) and make 50% of scholarship/fellowship awards to women students.

Results: Achieved. Of 107 total fellowships and scholarships that were awarded, 54 were given to women (50%) and 29 were given to students from underrepresented groups (27%).

Goal 1.4: Contribute to the STEM workforce by providing scholarship and fellowship support to high-performing undergraduate and graduate students attending MnSGC institutions, including support for students to participate in NASA Center internships.

Objective 1.4.A: Offer opportunities for all qualified students at our affiliates to participate in the MnSGC Fellowship and Scholarship Program in 2010-2011 by providing (a) at least 30 institution-specific undergraduate scholarships, (b) at least 4 Consortium-wide undergraduate scholarships, and (c) at least 2 graduate student fellowships (partial support).

Results: Achieved. Of 107 total fellowship/scholarship awards, 63 were made to undergraduates by MnSGC affiliates (i.e. not by the lead institution and not to students attending institutions outside the consortium) and 19 went to undergraduates at the lead institution. We also gave out 9 Consortium-wide scholarships (7 to undergraduate students at affiliates). As mentioned above, we also partially supported 8 graduate students with fellowships. Not included in these totals are another 12 students who received “scholarship” awards for summer internships, 11 of which were at NASA Centers. Included in the 8 fellowships (but not in the 12 summer internship total) was one student who received both fellowship support and also did a NASA Center summer internship.

Objective 1.2.2.B: Offer scholarship support for at least 6 students to participate in NASA summer internships and other activities at NASA Centers in 2010-2011. (Note that since final internship selections are made by the Centers, we cannot guarantee that this many Minnesota students will actually receive offers from NASA Centers.)

Results: Achieved. A total of 12 Minnesota students were partially-supported by the MnSGC at NASA Center internships during the summer of 2010. One additional student was supported at an industry internship.

Goal 1.5: Contribute to the STEM workforce by enhancing higher education opportunities for high-performing undergraduate and graduate students attending MnSGC institutions through aerospace design projects and student satellite projects.

Objective 1.5.A: Support the aerospace design program at the UMTC by providing at least 5 aerospace design projects sponsored by industry or government in 2010-2011.

Results: Achieved. Eight out of 11 aerospace senior design projects during the academic year of 2010-2011 were sponsored by industry or government.

Objective 1.5.B: Engage a new industrial partner, ASTER Labs, in the development of instrumentation for at least 1 student-launched flight project in 2010-2011.

Results: Not achieved. ASTER Labs is a small start-up company and was not able to provide adequate resources to support this objective during this time period.

Objective 1.5.C: Participate in the National Space Grant Student Satellite Program by maintaining at least 3 different types of active student aerospace hardware programs involving students from at least 3 different institutions in the MnSGC in 2010-2011.

Results: Achieved. High-altitude ballooning, high-powered rocketry, and suborbital rocketry (payload-building) programs are developing or in place at a total of 5 institutions in the MnSGC. One additional high-powered rocketry project was funded at a community college that is not currently an affiliate of the MnSGC (Inver Grove Community College).

Objective 1.5.D: Expand student-led high-altitude ballooning and/or suborbital programs to at least 1 additional affiliate in 2010-2011.

Results: Essentially achieved. Bemidji State University, working with nearby Central Lakes Community College, is developing a new high-altitude ballooning program. Faculty attended a ballooning workshop and are preparing to offer a ballooning workshop themselves for local pre-college teachers in June 2011. Admittedly, this initiative is not yet “student-led.”

Objective 1.5.E: Support participation in the NASA’s USLI (University Student Launch Initiative (high-powered rocketry) program) by community college students. Expect at least 1 faculty/student team to attend a USLI workshop and participate in the subsequent rocket competition in 2010-2011.

Results: Achieved. Special funding was extended to Inver Grove Community College (not yet an affiliate of the MnSGC) to send 1 faculty member and 2 students to a USLI workshop. They are now building a rocket for the spring 2011 USLI national rocketry competition.

Goal 1.6: Contribute to the STEM workforce by promoting higher education course development in areas of interest to NASA at MnSGC institutions.

Objective 1.6.A: Support undergraduate Higher Education activities at MnSGC affiliates by providing support for at least 5 new or ongoing courses or academic programs in 2010-2011.

Results: Achieved. MnSGC supported freshman seminars on ballooning and RC aircraft as well as the aerospace senior design class at the U of MN – Twin Cities (lead institution). Another 7 courses around the consortium were also supported, in physics, introductory engineering, astronomy, and planetary geology.

Objective 1.6.B: Develop new educational opportunities using radio controlled (RC) model aircraft design/build/fly programs. Expect course development will begin for a new freshman seminar in this area at the lead institution in 2010-2011.

Results: Achieved. This class sped through the development stage and is actually being offered in the Spring of 2011 (and is planned to be offered again in Spring 2012) at the U of MN – Twin Cities.

Goal 1.7: Enhance diversity in the STEM workforce by promoting research and/or higher education programming at tribal college affiliates of the MnSGC.

Objective 1.7.A: Enhance STEM educational opportunities at tribal college affiliates by facilitating at least 1 research or higher education program at both LLTC (a tribal college) and FDLTCC (formerly a tribal college) in 2010-2011.

Results: Achieved. Both LLTC and FDLTCC now have rocketry programs and both are involved in the First Nations Launch competition, sponsored by the WI Space Grant.

Objective 1.7.B: Support participation in model rocketry by tribal college students. Expect at least 1 model rocketry team to be operational at a tribal college (LLTC) in 2010-2011.

Results: Achieved. LLTC is participating in the First Nations Rocketry program. In addition, the American Indian Society of Engineers and Scientists (AISES) chapter at the U of MN – Twin Cities has also formed a high-powered rocket team and plans to enter that same competition.

Outcome 2: *Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty: (Educate and Engage)*

Goal 2.1: Enhance the teaching of STEM topics, especially in schools with high underrepresented populations, by supporting precollege teachers through a variety of aerospace-related professional-development opportunities.

Objective 2.1.A: Improve the formal and informal teaching of science and mathematics at the precollege level by offering at least 2 formal short-duration programs in 2010-2011 in which at least 50% of the participating teachers subsequently use the materials/activities in their own teaching.

Results: Partially achieved. Short-duration teacher workshops were offered to 46 in-service teachers on Geology, Laser Physics, and Aerospace topics by three different affiliates of the MnSGC. Only one of the three groups has reported on post-workshop participation so far, and their post-workshop implementation result was 80%.

Objective 2.1.B: Offer additional summer short courses and/or workshops especially for middle school educators and/or students at several venues in

Minnesota. Expect workshops or short courses specifically for middle school educators and/or middle school students will be delivered or developed at a minimum of 3 locations in 2010-2011.

Results: Achieved. In the summer of 2010 a four-day ballooning workshop was offered by the UMTC to 40 middle school Native American students on a reservation and a second 4-day workshop was offered to 17 teachers from 12 middle schools around the Twin Cities metro area. Year-round Astronomy instruction has also been provided to middle school students by one affiliate (Carleton College).

Objective 2.1.C: Promote the teaching of mathematics, science, and pre-engineering by working with teachers in 2010-2011 from at least 3 schools that serve primarily underrepresented students, to familiarize them with aerospace curricula.

Results: Achieved. Two MnSGC institutions work regularly with teachers and students in 16 schools in the Twin Cities metro area on ballooning, model rocketry, and/or suborbital rocket payload projects. Of these, 4 schools serve predominantly underrepresented students.

Outcome 3: *Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission: (Engage and Inspire)*

Goal 3.1: Promote familiarity with, and interest in, aerospace and space-related STEM fields and career opportunities by offering a variety of informal education activities around the state.

Objective 3.1.A: Promote aerospace and space related sciences through informal education activities around the state in 2010-2011. Survey a representative sample of participants and expect that at least 75% of respondents agree that the informal education activities were valuable to them (or to their groups, if they are a group leader).

Results: Essentially achieved. We offered informal education activities at 9 different affiliates, though not all activities were done in contexts where it was practical to formally survey attendees. The affiliates that were able to do so all reported that at least 75% of the participants agreed the activities were valuable to them.

NASA 2010 Education Priorities: *Accomplishments related to the "Current Areas of Emphasis"*

- Authentic, hands-on student experiences in science and engineering disciplines – the incorporation of active participation by students in hands-on learning or practice with experiences rooted in NASA-related, STEM-focused questions and issues; the incorporation of real-life problem-solving and needs as the context for activities.

Results: Aerospace hardware student-led teams and class projects bring hands-on NASA experiences to students at 8 different Minnesota colleges.

- Engage middle school teachers in hands-on curriculum enhancement capabilities through exposure to NASA scientific and technical expertise. Capabilities for teachers to provide authentic, hands-on middle school student experiences in science and engineering disciplines (see above).

Results: Our middle school ballooning initiative is engaging teachers and their students at 12 middle schools in and around the Twin Cities in (amateur) spacecraft building and (near-)space flight.

- Community Colleges – develop new relationships as well as sustain and strengthen existing institutional relationships with community colleges.

Results: A new relationship was established and special funding was granted to a non-member institution, Inver Hills Community College (IHCC), to start a USLI rocketry program. In the future IHCC may possibly join the MnSGC and/or assist other MnSGC members in getting involved in high-powered rocketry. High-powered rocketry has also been started at our two community college/tribal college affiliates, LLTC and FDLTCC.

- Aeronautics research – research in traditional aeronautics disciplines; research in areas that are appropriate to NASA's unique capabilities; directly address the fundamental research needs of the Next Generation Air Transportation System (NextGen).

Results: One Aerospace Engineering Ph.D. student (an African American) worked on computational hypersonics. Two Aerospace Engineering Masters Students worked on NextGen, one studying aircraft safety and the other working on “green” aircraft designs.

- Environmental Science and Global Climate Change – research and activities to better understand Earth's environments.

Results: Course development and/or course offerings in Environmental Science and in Global Climate Change occurred at 3 MnSGC affiliates in 2010-2011.

- Diversity of institutions, faculty, and student participants.

Results: The 14 MnSGC affiliates range from a small tribal community college to one of the nation's largest Ph.D.-granting public universities. One affiliate is a State Agency and one is a women-only institution. Affiliates are located in all geographical areas of Minnesota. Five affiliate directors or co-affiliate directors are female. Overall we achieved our goal for participation of underrepresented minority students but we are still below our objective metrics for female student participants. This is an area in which we need to work harder.

- Enhance the capacity of institutions to support innovative research infrastructure activities to enable early career faculty to focus their research toward NASA priorities.

Results: Two institutions in particular, Bethel University and Augsburg College, have been effective in connecting early career faculty with MnSGC funding opportunities and in focusing their research and making research collaborations in areas of interest to NASA.

PROGRAM CONTRIBUTIONS TO PART MEASURES

- Longitudinal Tracking:

Student Data and Longitudinal Tracking: Total awards = 43; Fellowship/Scholarship = 21, Higher Education/Research Infrastructure = 22; 6 of the total awards represents underrepresented minority F/S funding. During the FY10 program year 7 students being longitudinally tracked began pursuing advanced degrees in STEM disciplines, 1 accepted a STEM position at a NASA contractor,

2 accepted STEM positions in industry, and 1 accepted a STEM position in academia.

For all students that were significantly supported in the period spanning FY06-FY10, 18 continued on to pursue advanced degrees in STEM disciplines, 8 accepted STEM positions at NASA contractors, 1 accepted a position at NASA, 12 accepted STEM positions in industry, 3 accepted STEM positions in academia, and 1 went on to a position in a non-STEM discipline. The remaining students have not yet received the degree that they were pursuing when they received their Space Grant award.

- **Course Development:**
Higher education courses in areas of interest to NASA and using NASA content have been developed with Space Grant funding at multiple institutions in the MnSGC. The newest is a freshman seminar on RC aircraft at the U of MN – Twin Cities. Recently-revised courses include adding additional high-altitude ballooning activities to Techniques for Experimental Physics at Concordia College, developing labs for Fluid Mechanics as well as for Analog and Digital Electronics at Bethel University, developing a Field Geoscience for Teachers course at Bemidji State University, and making improvements to Introduction to Engineering at St. Catherine University.
- **Matching Funds:**
Non-scholarship Space Grant funding is matched 1 to 1 by in-kind and new-money contributions by the institutions offering programming. Match dollars are used to complement and expand upon Space-Grant-funded programming.
- **Minority-Serving Institutions:**
We currently have one minority-serving institution, Leech Lake Tribal College (LLTC). They are an active participant and have been using MnSGC funding to provide scholarships to their students, to fund a high-powered rocketry team that expects to build their first full-size rocket during the summer of 2011, and, most recently, to provide STEM outreach to Boys and Girls Clubs in their community.

IMPROVEMENTS MADE IN THE PAST YEAR

- **Increased support of graduate research**
This year the MnSGC considerably expanded the amount of funding going to graduate student research at the University of Minnesota. Traditional aeronautics and NextGen research were explicitly targeted for support. In addition, one graduate student was supported at an affiliate (Bemidji State University).
- **Expanded student aerospace hardware opportunities**
The MnSGC continued to expand aerospace hardware opportunities for students (student satellite projects) around the consortium. This year several affiliates began new projects in high-altitude ballooning, suborbital rocketry payload building, and high-powered rocketry. A faculty member in Electrical and Computer Engineering at the lead institution is now actively participating in suborbital payload development.
- **Expansion of pre-college involvement in high-altitude ballooning**
In-line with the new emphasis on engaging more middle school teachers and students, the MnSGC expanded high-altitude ballooning activities by providing

- ballooning workshops to Native American middle school students and, separately, to teachers from 12 middle schools in the summer of 2010. Those 12 schools are now building payloads that we will fly for them in the spring of 2011.
- **Initiation of Rocketry Activities**
Three Native American groups, one at Leech Lake Tribal College, one at Fond du Lac Tribal and Community College, and one at the University of Minnesota – Twin Cities, are participating in the First Nations Rocketry Competition. In addition, a student group at Inver Hills Community College will be participating in the University Student Launch Initiative (USLI) competition in the spring of 2011
 - **Addition of Freshman seminar in RC Aircraft**
A hands-on freshman seminar in RC Aircraft was offered at the University of Minnesota – Twin Cities during Spring 2011. It is planned to offer this seminar on a regular basis, to complement our High-Altitude Ballooning freshman seminar offered in the fall semester.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

- Augsburg College: M.S.-granting, private institution; Undergraduate Research/ Informal Education
- Bemidji State University: M.S.-granting, public; Undergraduate Research/ Higher Education/ Pre-College
- Carleton College: 4-year, private; Undergraduate Research/ Informal Education
- Bethel University: M.S.-granting, private; Undergraduate Research/ Pre-College
- St. Catherine University: M.S.-granting, private (main campus is women-only); Undergraduate Research/ Higher Education
- Concordia College: 4-year, private; Undergraduate Research/ Higher Education
- Fond du Lac Tribal and Community College: 2-year, public community college (combined with a 2-year tribal community college); Higher Education
- Leech Lake Tribal College: 2-year, tribal/ community college; Higher Education
- Macalester College: 4-year, private; Higher Education
- Minnesota Department of Transportation: State agency; Pre-College
- Southwest Minnesota State University: 4-year, public; Pre-College/ Informal Education
- University of Minnesota- Twin Cities: M.S.-granting, private; Undergraduate Research